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Virtual Reality, Graphics and mVEP Classification

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Introduction: Brain computer interfaces (BCIs) have often been interfaced with video games however the impact that video games graphics complexity has on brain-computer games interaction (BCGI) performance has not been studied. Additionally, with more advanced visual displays such as the Oculus Rift Virtual Reality (VR) headset there is a need to investigate any (dis)advantages these variables may have on BCGI. This is particularly relevant for visual evoked potential (VEP) based paradigms where visual distractions may have an impact on the reliability of the EP. In this study we utilized an Oculus Rift headset as a visual display to present a motion-onset VEP (mVEP) controlled car racing game [1] and compared the offline mVEP classification performance with the same game presented on a standard 22 inch LCD computer screen. We also compared two different levels of graphical complexity and background styles for the mVEP evoking stimuli. mVEPs are elicited by the sudden, brief motion (lasting 140ms) of an attended target/stimulus and consists of a negative peak around 200ms (P2) after the evoked stimulus, followed by a positive peak at around 300ms (P3) (Fig. 1a). mVEP stimuli are more elegant as they are motion related, do not require long training periods and are less visually fatiguing than other VEP stimuli [2].

Material, Methods and Results: Electroencephalography (EEG) with a twelve channel montage covering the occipital areas was recorded (Fig. 1b) whilst fourteen participants viewed five mVEP stimuli presented along with a car racing game. One session employed VR and the other a 22inch LCD monitor to display the stimuli/game. To compare graphical complexity and mVEP stimuli background variations, the participants were presented with four game levels in each session. Two levels offering different graphics (complex (Fig. 2a) and basic (Fig.2b)) and two levels with different stimulus background settings namely, stimuli overlaid onto the game environment using a non-white background (Fig. 2a) vs. stimuli placed on a white background (Fig. 2b). Five mVEP stimuli were employed, each corresponding to a different command (five classes). Each stimuli was activated sixty times yielding a total of 300 trials for each game level.

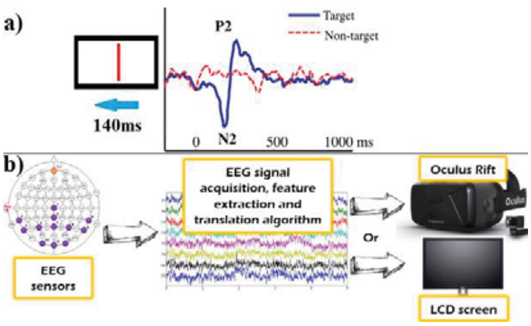

Figure 1. a) *mVEP stimuli details and* **b)** *BCI loop.*

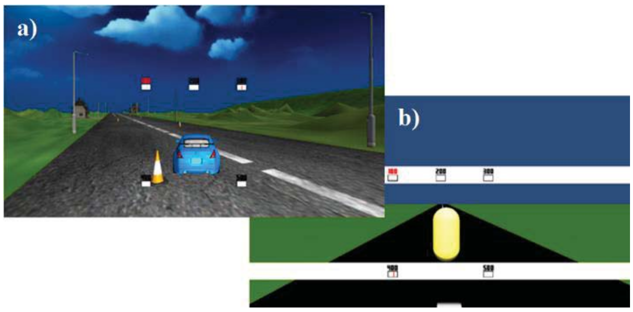

Figure 2. a) *Complex level no with white and* **b)** *basic level with white background.*

Offline analysis of mean accuracy across subjects for both target vs. non-target (two class) and five class mVEP classification indicates that VR presentation does not differ significantly from LCD presentation (69% and 70% for two class and five class respectively)(p>0.05). The differences between basic (69%) vs. complex (73%) graphics were significant (p<0.05). The differences using non-white (68%) vs. white (69%) backgrounds for mVEP stimuli are insignificant when basic graphics are presented (p>0.05), however the differences are significant when complex graphics are presented (non-white (70%) vs. white (74%), p<0.05).

Discussion: Offline analysis of results provide evidence for the first time that the Oculus Rift can be used for presenting low visually fatiguing mVEP stimuli without influencing classification performance and that the mVEP stimuli can be overlaid on basic games graphics without impacting performance significantly. The results however indicate that complex graphics improved mVEP classification performance and that when using complex graphics the mVEP stimuli should be presented onto a dedicated background and not overlaid on the games graphics i.e., a clear mVEP stimulus presentation area [3].

Significance: This pilot study provides evidence that realistic graphics and aesthetically pleasing game environments may be employed for BCGI using an mVEP paradigm, however the mVEP ‘controller’ should not be overlaid on game graphics but have consistent background (white tested here). The results will be validated in an online car racing game controlled using an mVEP paradigm taking into account the findings of this pilot study.

References:

[1] R. Beveridge, D. Marshall, S. Wilson, and D. Coyle, “Classification Effects on Motion-Onset Visual Evoked Potentials using Commercially Available Video Games,” in *The 20th International Conference on Computer Games*, 2015, pp. 28–37.

[2] F. Guo, B. Hong, X. Gao, and S. Gao, “A brain-computer interface using motion-onset visual evoked potential.,” *J. Neural Eng.*, vol. 5, no. 4, pp. 477–85, Dec. 2008.

[3] D. Marshall, R. Beveridge, S. Wilson, and D. Coyle, “Interacting with Multiple Game Genres using Motion Onset Visual Evoked Potentials,” in *The 20th International Conference on Computer Games*, 2015, pp. 18–27.